CLASSIFICATION OF BACTERIA:

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General Objectives:

1. To understand the different criteria used for bacterial classification.
2. To classify bacteria based on their morphological characteristics (shape and arrangement).
3. To differentiate between bacteria based on anatomical features (like capsule, flagella, and spores).
4. To understand and apply different staining techniques (Gram stain, Acid-fast stain).
5. To classify bacteria based on their relationship with the host (Saprophytes, Parasites, Commensals) and environmental factors (temperature, oxygen, pH).

- Bacteria can be classified in many ways. The first classification scheme was published in 1773 and many more have appeared since.
- Science of microbiology has developed other kind of classification but medically important classification is as follows

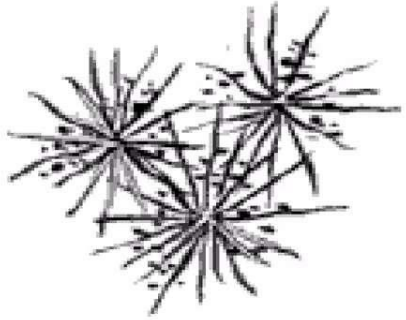
- Based on several major properties
  - Morphological
  - Anatomical
  - Staining
  - Based on pathogenicity
  - Based on relationship of host and organism.
  - Nutrition
  - Environmental factors

(1) MORPHOLOGICAL

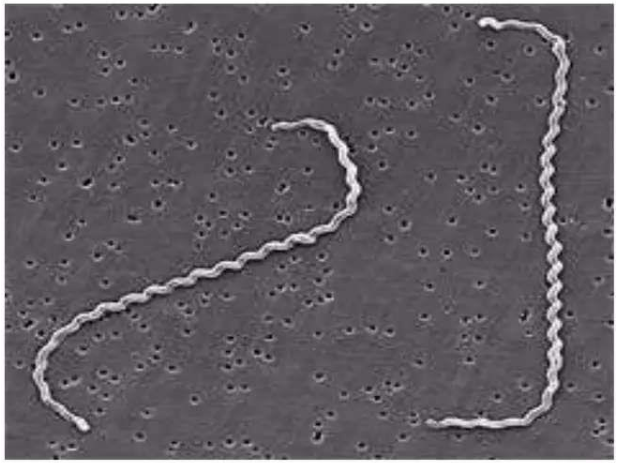
- Bacteria can be classified according to morphological characteristics like their cell shape, size and structure and their specific arrangement like motility and flagellar arrangement.
- Bacteria can be classified into **six** major groups on morphological basis.
- **1. TRUE BACTERIA**
- **Cocci** – These are spherical or oval cells. On the basis of arrangement of individual organisms they can be described as
  - **Monococci** (Cocci in singles) – *Monococcus* spp.
  - **Diplococci** (Cocci in pairs) – *Streptococcus pneumoniae*
  - **Staphylococci** (Cocci in grape-like clusters) – *Staphylococcus aureus*
  - **Streptococci** (Cocci in chains) – *Streptococcus pyogenes*
  - **Tetrad** (Cocci in group of four) - *Micrococcus* spp.
  - **Sarcina** (Cocci in group of eight)

- **Bacilli** – These are rod-shaped bacteria. On the basis of arrangement of organisms, they can be described as
  - Diplobacilli
  - Streptobacilli
  - Palisades
  - Chinese-letter form
  - Coccobacilli
  - Comma-shaped

- **<u>2. ACTINOMYCETES</u> (actin- ray, mykes- fungus)**
- These are rigid organisms like true bacteria but they resemble fungi in that they exhibit branching and tend to form filaments.
- They are termed such because of their resemblance to sun rays when seen in tissue sections.



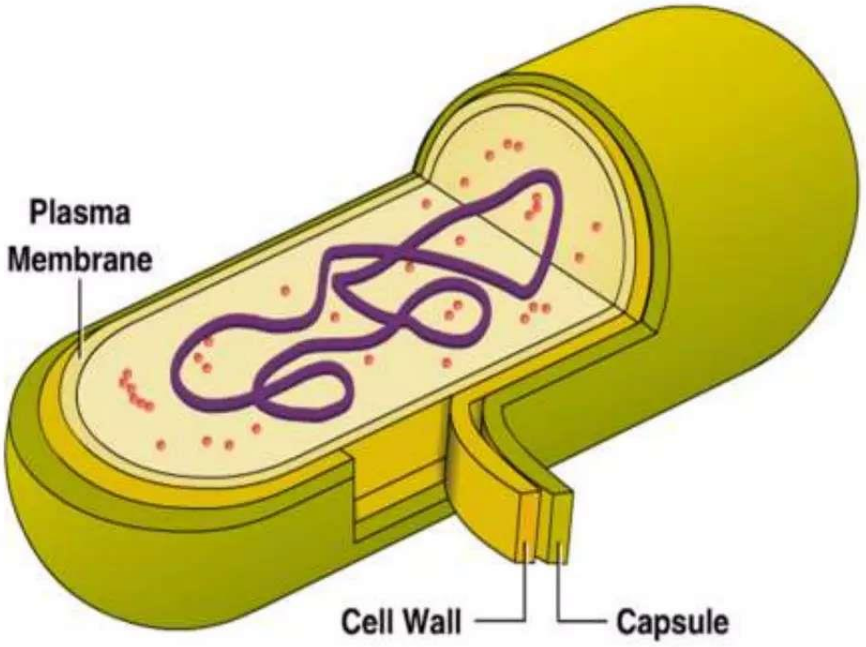
- **3. Spirochaetes**
- These are relatively longer, slender, non-branched microorganisms of spiral shape having several coils.



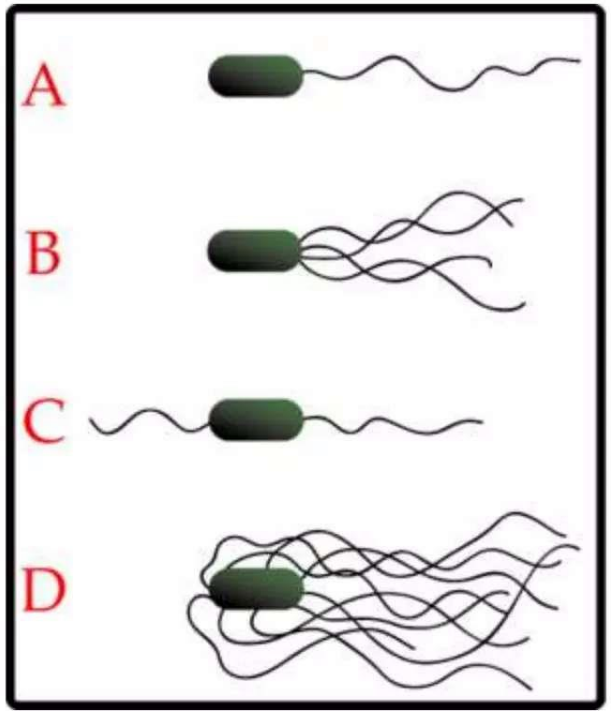
- **4. Mycoplasmas**
- These bacteria lack in rigid cell wall (cell wall lacking) and are highly pleomorphic and of indefinite shape.
- They occur in round or oval bodies and in interlacing filaments.
- **5. Rickettsiae and Chlamydiae**
- These are very small, obligate parasites, and at one time were considered closely related to the viruses. Now, these are regarded as bacteria.

BASED ON ANATOMICAL FEATURES

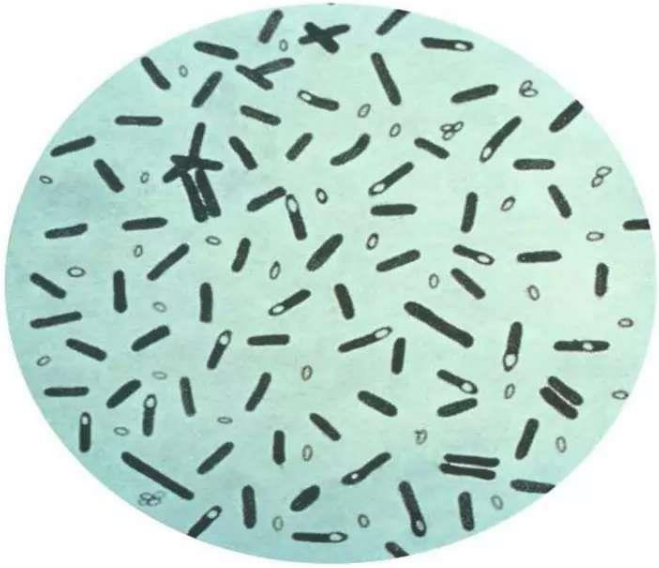
- Capsule
  - **Capsulate**– *Streptococcus pneumoniae*
  - **Non-capsulate** – Viridans streptococci



- Flagella
  - Flagellate –
    - Monotrichous
    - Lophotrichous
    - Amphitrichous
    - Peritrichous
  - Aflagellate – *Shigella* spp.



- Spore
  - **Spore-forming** – *Bacillus* spp.
  - **Non-sporing** – *Escherichia coli*



BASED ON STAINING REACTION

(a) **Gram stain:**

1) Gram positive: after the gram stain organism which occur violet in colour.
2) Gram negative: Which appear pink or red

(b)Acid fast stain:

1) Acid fast organism: after the ziehl – neelsen stain it will show pink in colour
2) Non acid fast organism: after this stain organism will appear blue in colour

Gram Stain

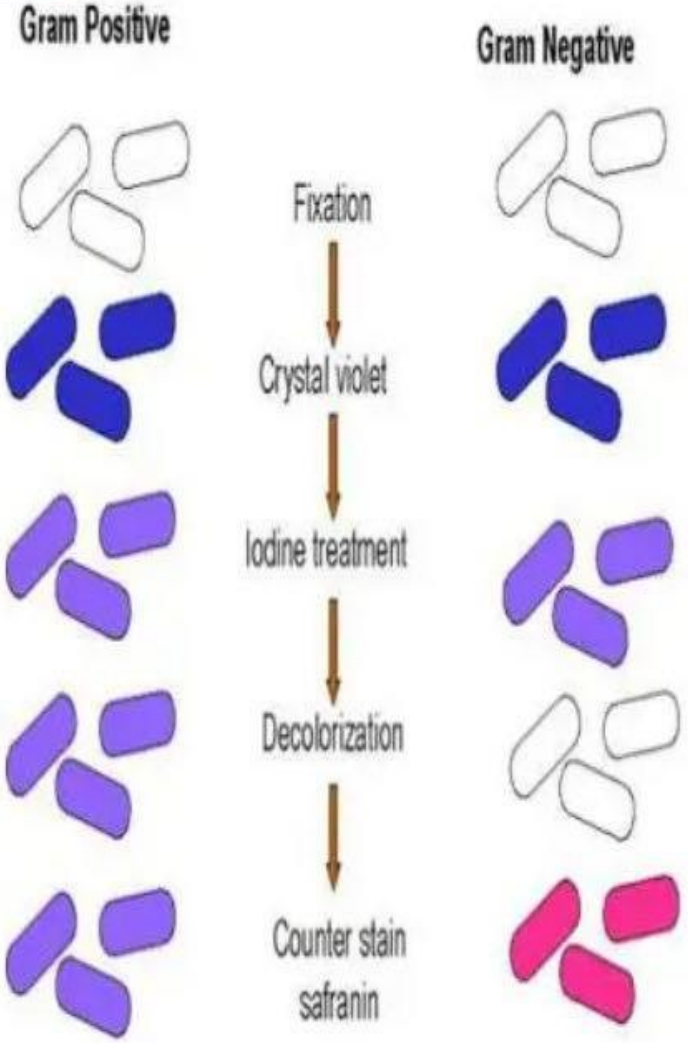
Principle of staining technique:

Primary stain:- Crystal Violet

Mordant(fixes the dye):- Iodine

Decolorizing agent:-Alcohol/Acetone

Counter stain;- Safranin



- **GRAM'S STAIN**
  - **Gram-positive cocci** – *Staphylococcus aureus*
  - **Gram-negative cocci** – *Neisseria gonorrhoeae*
  - **Gram-positive rods** – *Clostridium* spp.
  - **Gram-negative rods** – *E. coli*
- **ACID FAST STAIN**
  - **Acid-fast bacilli** –*Mycobacterium tuberculosis*
  - **Non-acid-fast bacilli** – *Staphylococcus aureus*

BASED ON PATHOGENICITY

A) pathogens: the organism which is able to spread disease and can cause disease.

B) Non pathogens: which does not cause and disease; e.x: lactobacilli

C) Commensals: normaly non pathogenic but sometime they show the disease when immunity impaired

BASED ON RELATIONSHIP OF HOST AND ORGANISM.

1) **saprophytes**: free living microbes on dead animals or decaying things that can be found in soil and water and play important role in degradation of organic matter.
2) **Parasites:** that establish themselves and multiply in hosts.
3) **Commensals:** microbes that live in complete live with harmony but they can produce disese when host resistance Is lowerd.E.x: normal flora organism

BASED ON NUTRITION

- Autotrophs
- Heterotrophs

BASED ON ENVIRONMENTAL FACTORS

- Temperature
- Oxygen dependence
- pH
- Salt concentration
- Atmospheric pressure

TEMPERATURE

- Psychrophiles (15-20^{0}C) – *Pseudomonas fluorescens*
- Mesophiles (20-40^{0}C) – *Escherichia coli*, *Salmonella enterica*, *Staphylococcus aureus*
- Thermophiles (50-60^{0}C)- *Bacillus stearothermophilus*
- Extremely thermophiles (as high as 250^{0}C)

OXYGEN DEPENDENCE

- **Aerobe** (grow in ambient temperature, which contains 21% O_2 and a small amount of CO_2, 0.03%)
- **Obligate aerobes** – Strictly require O_2 for their growth (*Pseudomonas aeruginosa*)
- **Microaerophilic** (grow under reduced O_2, 5-10% and increased CO_2, 8-10%)- *Campylobacter jejuni*, *Helicobacter pylori*

PH

- **Acidophiles** (*Lactobacillus acidophilus*)
- **Alkaliphiles** (*Vibrio*)
- **Neutralophiles** (pH 6-8)
- Majority of the medically important bacteria grow best at neutral or slightly alkaline reaction (pH 7.2-7.6)

Other ways of classification

- Motile/Non-motile
- Pathogenic/Non-pathogenic
- Sensitive/Resistant (to particular antibiotic/ chemicals)
- Lactose fermenter/Lactose non-fermenter

Thank you